Operational Remote Sensing Water Quality Meeting

Tuesday, October 7, 2003
8:30 a.m. – 4:30 p.m.
NOAA Coastal Services Center – Charleston, South Carolina

Executive Summary

A coastal water quality remote sensing meeting was held at the NOAA Coastal Services Center in Charleston, South Carolina, on October 7, 2003. The Center held this meeting based on the wide range of responses received for the Request for Information (RFI) that was issued in March 2003, as well as on the need for communication between the commercial, research, and management communities. The RFI was issued to help the Center determine current approaches to collecting coastal water quality data with remote sensing technologies. The meeting gathered representatives from the management, academic, and commercial communities to share the needs, desires, successes, and challenges involved in monitoring water quality with remote sensing. The meeting agenda is attached.

The meeting focused on the coastal management community's current capabilities and needs in using remote sensing technologies to monitor coastal water quality. In the morning session, coastal managers gave presentations on their current coastal water quality issues and how they believe remote sensing can help address those issues. Managers also described their needs regarding data delivery times, costs, and resolutions. Participants had an opportunity to provide insight on some of the successes and challenges they have experienced in using remote sensing to monitor water quality. Managers stressed that the data must be consistent, reliable, and affordable. They also put emphasis on the ease of access to and use of the data. The managers agreed that the data must be delivered in a timely manner and at the appropriate spatial scale to be useful in making decisions.

In the afternoon session, the participants discussed realistic specifications for a future demonstration of current operational water quality remote sensing technologies. Parameters of interest included chlorophyll concentration, turbidity, and temperature. Participants agreed that the data collected must be able to support monitoring efforts and coastal decision making, so timeliness of delivery and high spatial resolution are important characteristics. The participants felt that the final products should be delivered in an easy-to-use format, such as GeoTiffs that are compatible with GIS packages, and all data should be accompanied by metadata files.

Introduction

A coastal water quality remote sensing meeting was held at the NOAA Coastal Services Center in Charleston, South Carolina, on October 7, 2003. The meeting focused on the coastal management community's current capabilities and needs in using remote sensing technologies to monitor coastal water quality.

The main objectives of the meeting were

- To bring together coastal managers, academics, and commercial vendors who are working on water quality remote sensing programs to share their stories (successes, failures, and common needs)
- To understand the water quality monitoring needs of the coastal management community
- To solicit input on what might be included in a demonstration of operational water quality remote sensing

Presentations

Larry Harding of Horn Point Laboratory, University of Maryland, Center for Environmental Science
Aircraft Remote Sensing in the Chesapeake Bay

Ed Santoro of the Delaware River Basin Commission
Considerations for Future Remote Sensing Activities

Bob Connell of the New Jersey Department of Environmental Protection
Use of Remote Sensing for Routine Coastal Water Monitoring by a State Agency

Tiffany Moisan of NASA Goddard Space Flight Center
Technological Developments in Harmful Algal Bloom Detection

Rusty McKay of the Maryland Department of the Environment
Meeting on Coastal Water Quality Remote Sensing: Assessing the Current Needs and Capabilities – Shellfish Applications

Mark Trice of the Maryland Department of Natural Resources
Maryland DNR's Water Quality Monitoring Programs and Remote Sensing Applications and Needs

Bob Van Dolah of the South Carolina Department of Natural Resources Marine Resources Research Institute
State Agency Needs for Remote Sensing Data Related to Water Quality

Scott Stoodley of Applied Analysis Inc. and Tien-Shuenn Wu of the Florida Department of Environmental Protection
Monitoring Water Quality via Remotely Sensed Data: A Case Study in Choctawhatchee Bay, Florida

Summary of Conclusions from the Presentations

From the presentations, the participants learned that managers need data that is

- Consistent. Managers need data to be delivered in a consistent format and at consistent time intervals. Consistency will make comparisons between different data sets a more straightforward process. Receiving the data on a consistent schedule will increase its utility in coastal decision making.
- Reliable. Managers need to have data that they feel is reliable and respected by the management community in general. Many managers hope to use remote sensing to guide their monitoring efforts. Since their monitoring is often required by regulatory agencies, the reliability of the data is crucial.
- Comparable across time and space. The water quality data that is collected will be much more valuable if they can be used for comparison purposes with data collected at other time periods.
- Created with legally defensible processing methods. This goes back to the reliability of the data. The methods used to extract the parameters of interest from the data or imagery must be considered valid to the regulatory agencies requiring the monitoring and, therefore, must be defensible in court. The managers would like to see some type of standards document that defines standards for deriving water quality parameters from remote sensing data.
- Easy to access (data and instruments). The data needs to be easy to access, so that managers can get to it quickly when they need it to support a decision. The managers also would like to have easier access to the instruments that can be used to collect the data so that they could possibly collect data on their own.
- Delivered in a timely manner. Due to the speed at which most coastal processes occur, managers need data in-hand within 24 to 48 hours to be able to use it in decision making. Data any older than that usually do not give an accurate picture of the current state of the water column, since it is constantly changing.
- At appropriate temporal and spatial scales. Changes in coastal waters are often too quick for ship-based sampling methods to detect and too small for most satellite sampling to identify. Higher-resolution, more frequently collected data is needed for the data to be the most useful to coastal managers.
- Easy to use. Most management agencies do not have full-time remote sensing professionals on staff, nor do they have the resources to hire one. Often, they rely on the assumption that the data will be delivered to them in a format that is easy to use and understand. While most agencies have some type of GIS software package, many do not have the sophisticated software programs that are required to manipulate and process the data.
- Affordable. The limited budgets of many state agencies will not allow huge sums of money to be spent on data, especially if the utility of the data in decision making is still under investigation.

Breakout Sessions

After the managers' presentations, the participants broke into three groups to discuss realistic specifications for a future demonstration of operational water quality remote sensing technologies (see attachment for notes from each individual breakout session). Participants were asked to discuss the parameters of interest, an ideal location to hold the demonstration, data delivery specifications (delivery time, format, and mechanism), and any issues dealing with data accuracy or licensing.

Summary of Conclusions from the Breakout Sessions

Participants agreed that the parameters of interest included chlorophyll concentration and turbidity. Any additional parameters (temperature, dissolved oxygen) that could be offered with little effort would add value to the demonstration, but should not be the focus. The group agreed that in order for water quality data to support monitoring efforts and coastal decision making, it must be delivered in a timely manner and at an appropriate spatial resolution. Both time of delivery and spatial resolution needs depend upon the issue that is being addressed, but typically for coastal water quality monitoring, a quick turn-around time and high spatial resolution are desired. The participants felt that the final products should be delivered in an easy-to-use format, such as GeoTiffs that are compatible with GIS software packages, and all data should be accompanied by metadata files. The Internet was suggested as the ideal delivery mechanism for the data.

Ideally, the collection and processing methods used would be applicable to many types and sizes of aquatic environments so that the methodology could be carried to other areas. The participants felt that developing standard, reputable algorithms that are acceptable to the coastal management and legal communities would create a higher comfort level among coastal managers who want to use the data to help them meet their monitoring requirements. While remote sensing data alone could be used to monitor water quality, many of the managers felt that remote sensing would be more useful to help guide their monitoring efforts and support the monitoring data they collect in situ. The participants felt that remote sensing data could help to fill the temporal gaps that are not covered with boat sampling.

Additional Information

The meeting notes can be accessed at *www.csc.noaa.gov/crs/cwq/meeting*.
The meeting presentations can be accessed at *ftp://ftp.csc.noaa.gov/pub/crs/cwq*.
Additional information that meeting participants would like to add to the ftp site can be placed at *ftp://ftp.csc.noaa.gov/incoming/crs/wq_workshop*. Please notify Margaret VanderWilt (*Margaret.VanderWilt@noaa.gov*) or Dave Eslinger (*Dave.Eslinger@noaa.gov*) if you place items on this ftp site so that they can be transferred to the public ftp site.

NOAA Coastal Services Center
Operational Water Quality Remote Sensing Meeting Agenda
Charleston, South Carolina
Tuesday, October 7, 2003

Objectives:

- To bring together coastal managers, academics, and commercial vendors who are working on water quality remote sensing programs to share their stories (successes, failures, and common needs)
- To understand the water quality monitoring needs of the coastal management community
- To gather input on what should be included in a demonstration of operational water quality remote sensing

AGENDA

8:30	Welcome	Jeff Payne, NOAA CSC
8:45	Purpose of Meeting and Introductions	Dave Eslinger, NOAA CSC
9:30	Presentations on Water Quality Remote Sensing • Larry Harding, Horn Point Laboratory, UMCES • Tiffany Moisan, NASA • Bob Connell, NJ DEP and Ed Santoro, DE River Basin Commission	
10:30	Break	
10:45	Presentations on Water Quality Data Needs • Rusty McKay, MD Dept. of the Environment • Mark Trice, MD DNR • Bob Van Dolah, SC DNR • Tien-Shuenn Wu, FL DEP and Scott Stoodley, Applied Analysis	
12:00	Summary/discussion of morning presentations: What are the data needs?	Dave Eslinger, NOAA CSC
12:30	Lunch	
1:30	Request for Information results	Dave Eslinger, NOAA CSC
2:00	Group activity to develop water quality demonstration specifications	Breakout groups
3:00	Break	
3:15	Groups report out on results	Group representative
4:00	Concluding remarks	
4:30	Adjourn	

Breakout Group Notes

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Yellow Group Breakout Session

Brett Thomassie	Al Modjeski	Bob Van Dolah	Andrew Meredith
Jeff Leonard	Ed Santoro	Steve Raber	
John Lehrter	Dave White	Mary Culver	

Goal: provide useable data (useful to the decision maker)
- useable data – thought to be fairly general, could have many interpretations; may need to specify
    - legal, scientific, trend identification

Group discussion touch on issues relating directly to the demo and also to issues relating to an ongoing RS collection program

Agreement that there appears to be a common set of data needs (parameters)
- Chlorophyll, turbidity, temperature, DOC

Location:
- Selection should consider accessibility to other existing monitoring data sets (States all stick data in Storet)
- Important to identify a location that contains different kinds of water bodies
    - river dominated system
    - suggestions: Mobile Bay, Winyah Bay, & Delaware Bay
    - issue with Barnagett Bay b/c not true river dominated system
- Consider varied size of river system
    - How far up river is product valid?

Turnaround time: 24-48 hours
Frequency: every other week to month

Demo should be a demonstration of capability

Demo project should allow users (managers) to make linkages to existing monitoring data sets; investigate cause and effects

Demo Outcome:
- Cost/unit of effort
- Sample data product
- Constraints on the application of product
- Vendor plan that addresses a proposed approach for an operational program

    - Both routine monitoring & stochastic events
- Detail any licensing issues/restrictions

Format: GIS (ESRI)
Delivery: Internet (FTP)
Long Term Commitment: If it works, then there's good potential for a long term commitment ($'s being another important factor!)

Accuracy:

- Validation should be coordinated with state agency
- Relative measurements provide limited use
- Parameter dependent – 20-25% maybe OK
    - 10% or more variability on ground sampling measurements
- Awareness of threshold values
- Product should provide method to extract actual value

Issues about the temporal and spatial scales of a RS monitoring program

- What's the most important?
    - Possibly 2 tracks depending of issue
        - Spatial
        - Temporal
- Coastal managers would generally agree spatial coverage is good
    - Maybe not adequate to address all issues
    - Temporal coverage poor
- Trend analysis
    - Managing resources based on trends not stochastic events
- Event driven monitoring
    - Address cause and effect relationship

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Blue Group Breakout Session

Alan Cibuzar	Rusty McKay	Tiifany Moissan
Bob Connell	Scott Stoodley	Margaret VanderWilt
Larry Harding	Kirk Waters	Amanda Rutherford

Parameters to be measured

- Chlorophyll – Bob Connell
- Temperature
- Clarity/TSS
- TSI (Trophic Status Index) – include phosphorous, chlorophyll, sec. depth – Alan C.
    - last mapped in the late 1960s because they couldn't get anyone to buy it
- This can be done real time now, compared to a month that it took before
- Monitoring – Bob Connell is interested in chlorophyll monitoring from NJ's perspective
- Listing/delisting 303d
- Nonpoint source pollution – determining when entities break regulations is difficult to do. You don't want it to go to trial. Alan C. and Scott S.
- Algorithms must be scientifically backed by journals, peer reviews, etc. Federally recognized algorithms
- Most pollution is a result of ignorance – Alan C. Developers and factories break a lot of laws
- Agricultural runoff is another problem Alan and Scott
- Drawing the correlation between NPSP and agriculture is problematic Bob C.

Frequency and data collection

- Data from submarines will be real time
- Cost of subs is about $20K (? Can't hear)
- Managers really need to see the data in real time, so the turn around time must be short (i.e., instantaneous hand-held to one day turn around.)
- Accuracy could be a problem – calibration could be a problem, too
- For a submarine, the scale needs to be smaller to operate, such as in Monteray Bay, due to navigation
- Standardizing the methods would be a huge benefit

Geographic considerations

- Bays change significantly throughout the day - Alan
- The thermal region with high overcast skies is the optimal condition – Alan
- The networking system – something about a chip – to control data

- A lot of monitoring will be done in tributaries Chop Tank River (303D – fecal contamination) 2.5 miles across the bank of the river - Maryland (next year's TDML project)
- It is a rural environment, with unknown discharge sources
- Impervious surfaces are a leading problem?
- A small coastal bay would be preferred by Bob C., with high turbidity and highly mixed

Format of the data

- GeoTIF Bob C.
- Format can be as a DVD, or can be given in a Word format - Alan C.
- You don't need GIS, unless you are analyzing the data – just for visualization of data
- Have to conserve actual data if new algorithms are developed
- New data is being developed that will be required to …?
- Image format doesn't always work, since you are leaving it up to the vendor's interpretation of the data.
- New money is being spent on interpolators ? – Steve P. does this work
- Distribution needs to match – all specifics need to be developed in relation to what you plan on doing with the data
- Image data/permit
- Be sure to include metadata
- Compatible with ArcView
- Lat/long is provided and is then corrected. They do not georeference on the fly – Alan C.
- Discussion about polar orbiting and the amount of days it would it take to collect data based on satellite limitations
- Resolution
    - Quarter meter resolution can detect ground water pollution
    - It could be as broad as 4 meter resolution – but it all depends on what you are going to do with the data

Frequency of measurement

- Chlorophyll every day (Bob C.)

Licensing issues

- Licensing issues can increase competition between vendors
- Copyright protection is necessary
- Potential to hand over responsibility and get rid of licensing needs – having to get permission to reproduce is limiting
- No project is being done the same way for TMDL, so they can't be packaged together and used
- If each state could use the SAME tools the SAME way, then it would be more effective. A uniform system would be more effective
- Microwave license has to go through DNR for state – broadcasting FCC microwave frequency

- The ideal would be to get rid of any licensing agreements

Accuracy

- It depends how it is going to be used
- TMDL's are very accurate and need to be, but there are other cases where *some* accuracy can be forgone due to short turn around times
- Of course, the ideal is the most accurate data possible, but some managers would prefer the short response time to address blooms

Long-term commitment
Economy of scale

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Green Group Breakout Session

Kurt Allen	Dennis Hall	Mark Trice
Bill Bernard	Matthew Herring	Margaret Vo
Dave Eslinger	Jeff Leonard	TS Wu

DE: What's the management issue?

BB: It depends on whether we're looking statewide-are there common parameters each state needs?

KA: It has to be a success story-keep it simple. Don't make it a R&D effort but allow for the inclusion of value added criteria.

BB: Not all firms have the same capabilities and they can't all do everything you want. Stick with a set of minimum criteria.

KA: A smaller study area might be okay because the contractor might be able to do more with the money if the geographic extent is constrained.

BB: It might be better to sense everything in a smaller area than only a few parameters for the whole site.

MT: Why not HABs-we could get a better feel for some of the subtler aspects of the bloom and fill in some of the gaps with RS data.

DE: HABs might present operational obstacles.

BB: RS can help allocate scarce field resources to hotspot areas.

MT: HABs typically occur from late May to early June, which would help make sure there was activity to sense.

MV: Septic tanks might be an issue in SC-the use of dyes for tracing is an interesting idea. Have there been any wastewater treatment plant studies?

DE: Would RS add much?

MV: No, you really can't see it.

BB: Faulty septic tanks are green in winter, making them easy to spot. They are a big contributor to pollution in Chesapeake Bay.

MT: Temperature variation based on mixing and flushing of the estuary would be interesting to look at as well.

BB: We could easily measure SAV beds.

KA: I think of water quality problems as symptoms of larger terrestrial issues like stormwater runoff.

DE: Well, we agree that the parameters we need are color and temperature.

MH: Can we pinpoint which portion of the spectrum each of these criteria shows up on? Is so, we vendors can be more efficient in developing products.

JL: We need to know the spectral signature of what you're looking for but in the coastal environment, spectral signatures change a lot. What you should do is fly a variety of sensors under the same conditions and conduct simultaneous ground-truthing to see what identifies your parameters best.

MT: Chlorophyll is so variable that some level of aggregation is probably a good thing. Ground-truthing doesn't always match up perfectly with RS data anyway.

DE: We need the data product and metadata that is FGDC compliant.

JL: You also need some form of analysis.

KA: You also need to do an accuracy assessment.

JL: $20k is seed money. Give the vendors more time because they are already going to provide more than the $20k will actually pay for.

DE: Let's assume that the managers will provide the ground-truthing data rather than the vendors.

MT: We could do multiple segments of the Chesapeake and crop them down to the area of interest.

DE: A lot of the issues are along the tributaries-there's still value in doing one of those areas.

BB: We've had some good success with fall flights, but time of year does matter.

DE: How deep is the Bay?

MT: The average depth is about 20 feet.

KA: The Severn River is 5 miles long, maybe.

DE: What about doing it in the Chesapeake-both Bay and rivers?

KA: I would suggest considering the potential for funding opportunities from each state's congressional delegation when choosing a site.

DE: We definitely want chlorophyll and temperature (minimum criteria). Turbidity, salinity, chlorophyll type, and pigment are all value added criteria.

MT: Managers don't have the expertise or resources to process raw data.

JL: What software are most shops using?

DE: ESRI products for GIS and no one does much remote sensing. The data products need to GIS-ready and georeferenced.

JL: Would you provide the results of your ground-truthing to the vendor so they could use it in developing their process?

BB: What's the minimum mapping unit?

KA: We need to know what the minimum criteria are in order to do an accuracy assessment. Speed isn't an issue the second time around, assuming the algorithms have already been developed.

DH: The timeliness issue is how fast you can deliver the product once we go operational, not how quickly you can develop the algorithms.

MH: How will you discover the HABs?

MT: Using data from the fixed monitoring stations.

DH: Just assume that every two weeks you're going to collect this data. Now how long would it take?